LOCAL PECULIARITIES OF WIND VELOCITY AND MOVEMENT ATLANTIC SEABOARD—EASTPORT, ME., TO JACKSONVILLE, FLA.

By SPENCER LEE TROTTER.

[Philadelphia, Pa., June 4, 1920.]

INTRODUCTION.

A study of the conditions of wind velocity and movement along the Atlantic coast of the United States brings to light a number of interesting local peculiarities at the 14 coastal stations selected. Figures for velocity and movement covering a period of five years (1915 to 1919) show such marked contrasts for these stations as to raise the question in the mind of the student as to the reason for their existence. The outstanding features are: First, the difference in velocity and movement between Nantucket and Block Island; second, the marked difference between Sandy Hook and Atlantic City; and third, the increase of wind movement and velocity southward to Hatteras, the decided decrease at Wilmington, N. C., and the corresponding increase again southward to Jacksonville, Fla. At first thought it would be natural to suppose that differences in exposure of the various anemometers would be in a large measure resp nsible, and exposure undoubtedly has some effect on the velocity and movement of the wind at certain stations, especially as regards winds from certain directions.

It is my aim only to point out the conditions as they exist, with the aid of the tables and chart, and to suggest certain causes that may have a deciding influence, the principle cause being the contour of the coast, and topography at various stations of such a character as to affect the movement of surface winds. For this reason, purely ocean data have not been used in this article, as it has to do only with the effect that land may have on coastal winds.

WIND MOVEMENT AT VARIOUS STATIONS.

Eastport, Me.—The first station to be considered is Eastport, Me., situated on an island in the southwest portion of Passamaquoddy Bay, with a narrow, open exposure to the northeast between two Canadian islands, and a fairly open exposure to the west, across a bay between it and the mainland. It gives a total five-year movement of 477,485 miles and a monthly mean of 7,951 miles, with the prevailing wind from the S.; the wind prevailing in that direction, 29 out of 60 months. High velocities, on the other hand, are almost invariably registered from the E. and NE., with a mean maximum velocity of 49 miles per hour from the E. and 46 miles per hour from the NE., as shown in Table 3. "Frequency by Direction" part of the same table, also shows values from the E. and NE. far in excess of any other direction. The prevailing S. wind is due probably to the passage of the great number of LOWS eastward out the St. Lawrence Valley, while the high velocities can be traced to three causes, namely, good exposure of the anemometer to the E. and S.; track of LOWS that move NE. up the coast or east across the Maritime Provinces and largely dominate high-wind velocities in this locality; and the narrow, open exposure to the NE., as before mentioned.

Portland, Me.—At Portland, Me., situated on the SW. side of Casco Bay, with a fairly open exposure to the E. and NE., we find a decided decrease in the total wind movement, in the number of winds, 50 miles per hour and over, and in the mean maximum for the five-year period; this last, 36 miles per hour against 44 at Eastport. Though the exposure of the Portland anemometer is good and 32 feet higher than that of Eastport, it must be borne in mind that the former is a city exposure and must necessarily be affected to some extent by the buildings surrounding it. As in the case of Eastport the prevailing wind direction is S., but the greatest value for the relative frequency is NW., being 18, with 6 for SE. as second. How great an effect the surroundings have upon the local conditions is hard to tell, but the fact that the maximum velocities are mostly registered from the NW., where comparatively high ground exists may be one influence responsible for the decrease in velocity.

Boston, Mass.—In this connection it is interesting to note that Boston, with a poor exposure, shows a greater total movement and monthly mean than does Portland, though the mean maximum for the former station is 1 mile per hour lower. We again have to take into consideration the question of surroundings, and no fair estimate can be gained of the real conditions of wind existing at this point, but at the same time it is well to note the difference between Boston and Portland in connection with the land topography to the SW., W., and NW., and the possible effect that the same may have upon the wind at these two points. SW., W., and NW. of Portland the land is comparatively high, while at Boston it is only moderately hilly and would tend naturally to give greater movement. In the case of maximum velocities, the Boston exposure is without doubt the principal reason for the relatively low readings, and it is well known that velocities at Boston Light and points beyond the harbor greatly exceed those of the city.

Nantucket, Block Island, and Sandy Hook.—At the three stations of Nantucket, Block Island, and Sandy Hook, we are able to gain a better idea of the true conditions of coastal wind velocity and movement, and find differences that again bring up the question of topography and its influence on surface winds. At Nantucket we have a total five-year movement of 702,355 miles and a monthly mean of 11,706 miles; prevailing wind from the SW., 40 winds 50 miles per hour or over, and a mean maximum of 50 miles per hour, with a relative frequency value of 25 from the NE. At Block Island we have a total movement of 779,878 miles and a monthly mean of 12,988 miles, prevailing wind from the SW., 109 winds 50 miles per hour or over, with a relative frequency value of 30 from the NW. It can be seen from the above that there is a decided increase in both velocity and movement at Block Island, and though, as a whole, the exposure of the Block Island station is better than that of Nantucket, it does not seem that this is great enough to be responsible for the whole difference, especially as regards the number of winds 50 miles per hour or over; Block Island registering 69 more than Nantucket.

The reason for this difference may lie in the fact that Block Island is situated within a short distance of the mouth of Long Island Sound and the possibility of surface winds becoming contracted or funneled by two masses of land flanking a body of water such as the Sound. That surface winds tend to contract and become stronger, seems to be borne out in the case of river valleys, and it is reasonable to suppose that the conditions at Block Island are governed by the same cause.

At Sandy Hook there is a decrease in movement, but little or no decrease in velocity, a prevailing NW. wind, and a relative frequency value of 26 from the NW. The contour and topography of the coast in this locality is such as would tend to funnel winds, as in the case of Long Island Sound, and it certainly seems that there is some definite cause for high readings here, when we pass south to the Atlantic City station, less than a hundred miles distant, and find a decrease in total movement of over 300,000 miles, and in monthly mean of over 5,000 miles, with no winds of 50 miles per hour or over during the five-year period, compared with 106 at Sandy Hook. At no two other stations on the coast is the contrast so striking, and it seems even more certain in the cases of Atlantic City and Sandy Hook, that exposure is not responsible. The land to the west of Atlantic City is practically flat, which, with the presence of the Atlantic Highlands to the west of Sandy Hook, would seem to strengthen the theory of higher velocity and movement by contraction or funneling. At any rate, there is no apparent natural cause in the locality of Atlantic City that would tend to decrease the velocity and movement of the wind, and the nearness of it to Sandy Hook would preclude the possibility of the movement of LOWS having anything to do with the decrease.

Cape May, N. J.—A short distance to the south, at Cape May, there is a slight increase in velocity and movement, which may be attributed to the fact that it is practically surrounded on three sides by water. Five-year statistics for the Delaware Breakwater (12 miles to the south) were not available at the time this article was written, but such figures as have been noted for a shorter period, point to the fact that there is a decided increase in both velocity and movement at this station. The fact that it has an open northwest exposure may be largely responsible for this, however.

Cape Henry, Va.—At Cape Henry, Va., there is a material increase in velocity and movement, the station registering a total movement of 598,800 miles, a monthly mean of 9,980 miles, and a mean maximum of 50 miles per hour, while the maximum relative frequency value is 25 north. The location of the Cape Henry station as regards the surrounding bodies of land and water is much the same as that of the Delaware Breakwater, and the comparatively high figures might be attributed to the same causes that control the conditions there. There is, however, an increase in movement of a marked character at the Hatteras station, though a slight decrease in velocity, and even taking into consideration the fact that the Hatteras station has a sea exposure on practically all sides, it hardly seems that this, combined with the location of the Cape Henry station would form a deciding factor in the great differences of velocity and movement between the Hatteras-Cape Henry and Cape May-Atlantic City stations.

Wilmington, N. C.—At Wilmington, N. C., there is a marked decrease again, with readings that are approximately the same as those of Atlantic City. It is interesting to note in connection with this, that the trend of the coast at these two stations is practically the same, or in other words, NE. to SW.

Charleston, Savannah, and Jacksonville.—Again we might attribute the decrease at Wilmington to the fact that the station is some miles from the sea, were it not for the increase at Savannah and a further increase at Jacksonville, both stations some 20 miles inland. Charleston shows higher readings than Wilmington also, though the proximity of the former station to the sea would not make a material increase unnatural. Velocity readings, however, for both Savannah and Jacksonville are higher than those for Charleston, with Savannah and Jacksonville showing mean maximums of 41 and 44 miles per hour, respectively, and Charleston only 37 miles per hour. As regards winds, 50 miles per hour or over, Savannah and Jacksonville also show a very marked contrast with Charleston; the first two stations with 15 and 23, respectively, and the last-named station with 4.

Figure 1 shows the relative wind passage at the various stations with respect to the contour of the coast More complete data are given in the tables.

A possible reason for the increase of movement and velocity at certain stations north of Hatteras has been given, but this does not seem to explain the decrease at Wilmington and the succeeding increase at Charleston,

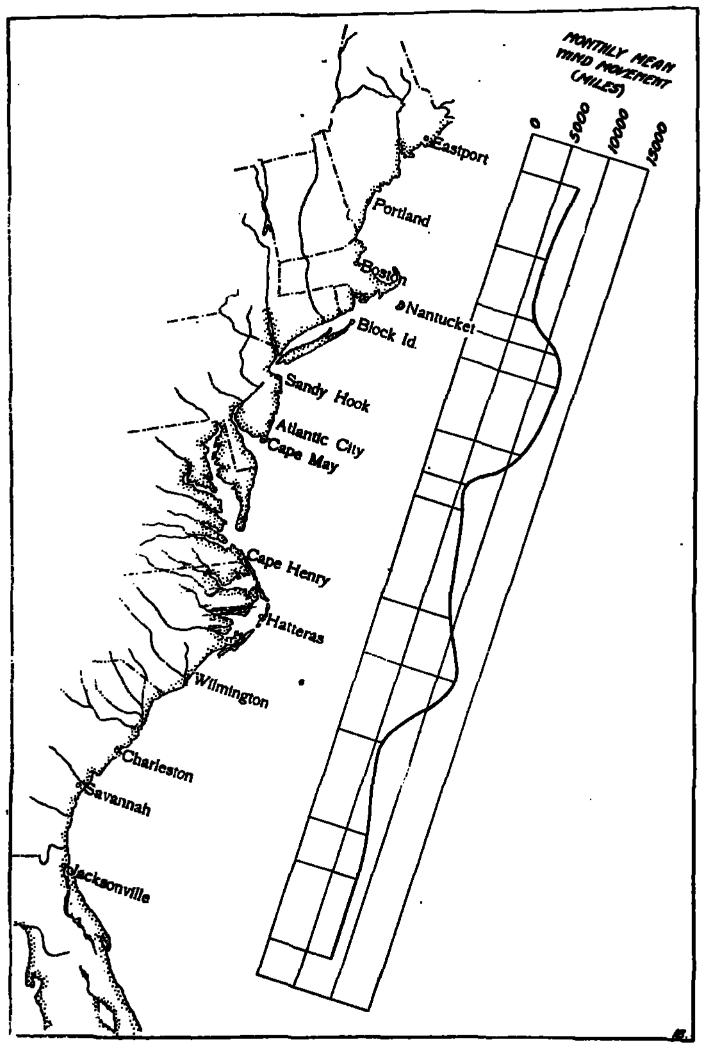

FIG. 1.—Monthly mean wind movement at Atlantic Coast stations.

Savannah, and Jacksonville; differences too marked and general to be governed solely by location. How much influence the trend of the coast has, if any, is a matter not easy to determine with only statistics for widely separated points, where several foreign elements tend to detract from fair readings, but the charts certainly seem to show that there is some definite connection between coastal contour and wind, with the possible effect of topography in certain local areas such as Sandy Hook, taken into consideration.

CONCLUSION.

In conclusion, it may be said that it would be almost worth while to obtain as nearly free readings along the coast as possible, at various points and in the course of a number of years compare the results obtained. From these, some definite conclusions might be arrived at that would prove, at least, interesting, if not valuable. Ocean data are valuable only so far as they have to do with the ocean, but the influences that govern the conditions there are certainly not the same as those that exist within a short distance of the coast, where hills, river mouths, bays, islands and sounds each become influences of their own on velocity and movement of surface winds, and must go as a whole to form a governing factor in the general movement of winds from various directions. How great this factor is, we have yet to learn.

DISCUSSION.

The author believes that there is some influence other than local topography and the exposure of the anemometer responsible for the variation in wind velocity at certain points along the Atlantic coast. Personally, I think the high winds at Sandy Hook as compared with Atlantic City on the south coast are due almost wholly to the open water surface to the northwest of Sandy Hook. For a similar reason the strong winds at Cape Hatteras as compared with Wilmington, N. C., may be explained. The reason for higher winds at Block Island than Nantucket is not so apparent. I should expect that with northeast winds the velocities would be very nearly the same since the free-water surface in that direction is very nearly the same. With northwest winds, however, Nantucket is blanketed more or less by Marthas Vineyard which lies directly to the northwest of Nantucket.—*A. J. Henry.*

TABLE 1.—*Wind movement.*

Station.	Height of anemometer above ground.	Yearly movement.					Total movement.	Monthly mean.	Number of months by prevailing direction.								Prevailing direction.	Anemometer exposure.
		1915	1916	1917	1918	1919			N.	NE.	E.	SE.	S.	SW.	W.	NW.		
	Feet.	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*										
Eastport, Me.	85	94,673	95,920	98,371	94,253	94,268	477,485	7,951	1	1	0	0	29	1	12	16	s.	Good E. to S.; fair NW.-N.
Portland, Me.	117	79,982	84,963	81,438	76,300	79,366	402,094	6,702	9	1	3	0	21	6	3	17	s.	Good.
Boston, Mass.	188	89,038	93,298	90,723	87,444	87,222	447,725	7,454	0	0	6	0	0	23	19	12	sw.	Poor.
Nantucket, Mass.	90	137,711	141,757	138,430	144,617	139,840	702,355	11,706	2	8	0	0	0	32	3	15	sw.	Good E. to NE.; fair W. to S.
Block Island, R. I.	46	154,313	160,504	156,203	153,774	155,084	779,878	12,998	1	5	0	1	0	26	5	22	sw.	Good.
Sandy Hook, N. J.	57	136,832	131,208	140,166	136,755	139,039	684,000	11,400	0	4	0	1	13	5	10	27	nw.	Do.
Atlantic City, N. J.	48	71,696	73,680	71,598	68,988	68,275	354,237	5,904	1	2	0	0	7	22	0	28	nw.	Fair.
Cape May, N. J.	49	79,054	81,237	77,574	[1] 53,780	[2] 55,464	[3] 347,109	[4] 6,549	5	1	3	2	20	2	1	19	s.[3]	Do.
Cape Henry, Va.	58	116,863	123,369	123,853	116,688	118,027	598,800	9,980	7	13	0	2	8	29	1	0	sw.	Good NE.; fair W.
Hatteras, N. C.	50	126,732	132,306	141,294	[5] 106,955	122,023	[6] 729,310	[7] 12,361	13	17	0	0	1	27	1	1	sw.	
Wilmington, N. C.	91	65,931	69,418	67,363	66,882	63,957	333,551	5,557	91	13	1	0	1	26	10	0	sw.	Good NE.; fair W. to S.
Charleston, S. C.	92	88,662	96,303	92,604	91,935	92,313	461,817	7,697	11	12	3	0	18	12	2	2	s.	Good NE.; fair W. to S. sea.
Savannah, Ga.	194	96,267	104,635	95,132	94,278	95,839	486,151	8,102	2	18	2	3	7	19	6	3	sw.	Good 20 miles from ocean.
Jacksonville, Fla.	245	[8] 67,924	109,919	106,739	104,806	104,259	[9] 493,647	[10] 8,227	4	17	1	7	1	24	3	3	sw.	

[1] 8 months.
[2] 9 months.
[3] 53 months.
[4] Mean for 53 months.
[5] 11 months.
[6] Total for 59 months.
[7] Mean for 59 months.
[8] 8 months.
[9] Total for 56 months.
[10] Mean for 56 months.

TABLE 2.—*Velocity (miles per hour).*

Stations.	Mean maximum, by years.					5-year mean.	Absolute maximum, by years.					Number of winds, 50 miles per hour or over, by months.												Total.
	1915	1916	1917	1918	1919		1915	1916	1917	1918	1919	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
Eastport, Me.	44	45	47	43	43	44	NE. 63	NE. 77	E. 70	E. 67	NE. 72	4	1	7	1	0	0	1	1	0	3	6	4	28
Portland, Me.	39	34	36	38	34	36	NW. 54	NW. 48	SE. 60	NW. 56	NW. 48	0	0	1	0	0	0	0	0	1	0	0	2	4
Boston, Mass.	36	35	35	36	34	35	NE. 52	W. 47	E-NE. 48	W. 48	NW. 43	0	0	0	0	0	0	0	0	0	0	0	1	1
Nantucket, Mass.	54	47	56	47	46	50	NE. 79	NE. 67	SW. 76	S. 60	SW. 56	5	4	3	6	1	0	1	0	3	3	2	12	40
Block Island, R. I.	58	53	54	52	53	54	W. 86	NW.-W. 72	E. 76	NW. 70	NW. 70	16	20	20	6	3	0	0	1	2	6	11	24	109
Sandy Hook, N. J.	58	53	57	53	55	55	W. 76	NW. 65	S. 73	NW. 74	W. 76	14	14	18	14	2	1	3	6	2	5	8	19	106
Atlantic City, N. J.	32	28	30	30	29	30	NE. 49	NE. 38	SE. 44	NE. 38	NE-NW. 39	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape May, N. J.	35	34	35	37	32	35	E. 48	NW. 50	S. 48	S. 52	NW. 42	1	0	0	1	0	0	0	0	0	0	0	0	2
Cape Henry, Va.	51	49	47	48	54	50	NE. 74	NE. 56	N. 60	E. 54	N. 68	1	5	7	7	0	7	2	3	3	1	1	4	41
Hatteras, N. C.	49	46	47	51	43	47	W. 66	NW. 64	NW. 66	SW. 72	N. 54	4	7	5	5	0	3	2	2	0	1	2	7	38
Wilmington, N. C.	32	29	35	34	27	31	S. 43	W. 38	SW. 47	NE. 60	NE. 36	0	0	0	1	0	0	0	0	0	0	0	0	1
Charleston, S. C.	37	39	38	36	35	37	SE. 54	N. 64	NE. 46	S.-E. 47	NE. 51	0	0	0	0	0	0	3	0	0	0	1	0	4
Savannah, Ga.	46	42	41	37	41	41	SE. 62	NW. 52	NW. 60	SW. 56	W. 46	2	4	2	0	1	2	2	0	0	0	1	1	15
Jacksonville, Fla.	47	44	46	44	41	44	SW. 64	SW. 54	SW. 60	SW. 59	SW. 54	2	3	1	2	3	2	6	3	0	0	0	1	23

NOTE.—Records for Cape May, Hatteras, and Jacksonville cover 53, 59, and 56 months, respectively; details in Table 3.

TABLE 3.—*Wind velocity and direction.*

Station.	Mean maximum velocity by direction.								Relative frequency by direction.							
	N.	NE.	E.	SE.	S.	SW.	W.	NW.	N.	NE.	E.	SE.	S.	SW.	W.	NW.
Eastport, Me..	...	46	49	38	44	.....	38	32	0	[1]21	15	5	5	0	5	7
Portland, Me..	30	35	37	39	33	27	31	38	2	9	3	9	5	2	2	[1]28
Boston, Mass..	31	38	34	38	29	30	38	36	4	8	9	2	2	4	[1]19	15
Nantucket.....	43	51	54	48	45	53	49	43	4	[1]25	3	2	3	19	2	2
Block Island...	54	50	54	60	...	35	53	56	1	8	6	1	0	2	12	[1]30
Sandy Hook...	50	62	57	60	57	55	63	53	7	3	3	1	11	2	10	[1]26
Atlantic City..	19	35	24	30	25	23	26	32	3	[1]15	5	8	14	6	2	13
Cape May......	...	30	34	34	45	35	34	33	0	5	5	8	4	1	1	[1]14
Cape Henry...	48	49	57	....	48	46	....	49	[1]25	20	3	0	1	1	0	10
Hatteras.......	47	44	62	55	50	45	45	47	[1]20	4	1	1	4	8	9	15
Wilmington...	30	37	24	37	35	31	32	38	4	11	5	2	5	[1]21	10	2
Charleston.....	38	37	31	35	41	33	38	35	6	[1]21	4	4	9	10	5	5
Savannah......	35	44	31	39	38	44	41	43	4	3	10	6	5	3	13	[1]18
Jacksonville...	44	41	39	37	44	47	52	45	3	6	2	3	6	[1]20	3	6

[1] Indicates prevailing direction.

NOTE.—Data from the following stations is missing: For Cape May, April, July, and August, 1918; January, February, and March, 1919; for Hatteras, October, 1918; for Jacksonville, January, February, March, and April, 1915.

THE ACCURACY OF WIND OBSERVATIONS IN LARGE CITIES.

By G. HELLMANN.

[Abstracted from Bericht über die Tätigkeit des Preussischen Meteorologischen Instituts in den Jahren 1917, 1918, 1919, pp. 24-29.]

The necessity of observing the direction of the wind from wind vanes has led to the placing of vanes on buildings in cities which are but poorly exposed to the wind, and, being influenced by eddies and deflected currents from adjacent buildings, they not only fail to agree in results with those exposed openly but also disagree with other poorly exposed vanes.

The author has investigated this question for five years, 1911–1915, at three stations located in Berlin. The Urban municipal hospital is located near the south limit of Berlin, the Agricultural high school is 4.5 kilometers northwest of Urban, and a third station located in Seestrasse was 3.1 kilometers northwest of the high school on the northwest limit of Berlin. The relative number of wind directions recorded by the three stations in those years is as follows:

	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.
Urban...........	100.4	40.0	142.8	77.6	211.4	172.8	193.8	132.2	24.6
High school........	66.4	103.4	126.0	115.0	118.7	163.2	256.5	124.2	22.2
Seestrasse..........	87.0	112.0	135.2	83.6	158.6	158.0	266.4	84.2	10.6

Most conspicuous in this table are the differences between the three stations with south and with northeast winds. The Urban station recorded about twice as many south winds as the high school, while the Seestrasse station recorded three times as many northeast winds as the Urban station. This is probably due to the situation of these stations with respect to the city. Seestrasse, on the northwest received more northeast winds; Urban, on the south, had a preponderance of south winds.

Of interest, also, are records made between 1775 and 1787 within Berlin, which, then, of course, was much smaller than now. One observer was Beguelin, who observed from the old observatory in Dorotheenstrasse for the Academy of Sciences, and the other was Gronau, the minister of the Parochialkirche, who observed the vane on his church steeple. The two points lay about 1.5 kilometers apart. Their records show very poor agreement as to frequency. The best agreement occurred in the months of May, June, and July when the north wind is prevailing. Throughout the year Gronau had more southwest winds than Beguelin, and, in general, he also recorded more west winds, while Beguelin noted more north, south, and southeast winds.

These records show how unreliable are many of the records of wind direction obtained in cities. The observations of Beguelin and Gronau show also that recording instruments are essential, for their best agreement was in those months when long daylight and clear weather aided their observing in morning and evening.—*C. L. M.*

GROUND TEMPERATURES COMPARED WITH AIR TEMPERATURES IN A SHELTER.

By GEORGE REEDER.

[Weather Bureau, Columbia, Mo., Oct. 19, 1920.]

SYNOPSIS.

A series of observations was made at the United States Weather Bureau Station, University of Missouri, Columbia, during the months of September and October, 1907, to determine how much exposed thermometers on the ground differed from sheltered thermometers 11 feet above the ground. To test the problem further, three beds were made, one of bare soil, one of blue-grass sod, and one of sand. Observations made during the passage of cumulus clouds and upon the effect of a shade area 20 feet distant showed that all the instruments responded to cloud shadows, but that only ground thermometers showed the effect of the building shadow. The latter shadow caused a perceptible movement of air toward the sunlit area. This paper serves to present the collected data from these observations.

RESULTS.

Equipment.—The equipment consisted of maximum, minimum, wet and dry bulb thermometers and a thermograph, in the shelter, and of one minimum and one dry bulb thermometer on each of three beds. The beds consisted of small adjoining plots of bare soil, blue-grass sod, and sand, each 18 inches square. The shelter, which was of the usual Weather Bureau type, stood 11 feet above the ground. The beds lay on the south side of the shelter so that on bright days the shelter shadow was thrown away from the thermometers exposed in the beds. The thermometers were placed, with the bulbs partly, but not wholly, covered, pointing to the north. For protection from interference and accidents, the three beds were covered with a strong 3-inch mesh wire cage, the four corner wires being driven into the ground. The observations were made with the dry bulb thermometers at 2 p. m. and sunset and each morning with the minimum thermometer.

The accompanying tables and diagram show that during September nights bare soil cools slower than either sod or sand. Generally, it was cooler on the ground during clear nights than in the shelter; during calm, clear, dewy nights bare soil was the warmest, as a rule. In the middle of the day during September, under bright sunshine, bare soil and sand went to higher temperatures than the sod; and the temperature changes with the passage of a cloud also were greater on bare soil and sand than on sod. During cloudy, damp weather ground-surface temperatures were moderate and varied but little. The loss of heat from the bare soil surface was quite marked after September 20.

The warmest period was from September 11 to the 19th, inclusive (see fig. 1). The 16th was the warmest